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Li Insertion into Li-Ti-O Spinels: Voltammetric and Electrochemical Impedance Spectroscopy Study

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Abstract

The insertion of Li into nanocrystalline Li-Ti-O spinel electrodes was studied using cyclic voltammetry combined with electrochemical quartz crystal microbalance, open circuit potential measurements, and electrochemical impedance spectroscopy studies. Insertion characteristics of spinel were compared with those of titania polymorphs. The insertion into spinel occurs at potential 300 mV more negative to that of insertion into anatase, and about 40 mV positive to that into rutile. The specific capacity (160 mAh/g) is comparable with that of TiO2 polymorphs. Due to the relatively negative potential of the insertion and significantly lower tendency to self-discharge, Li-Ti-O spinel is more convenient for use in a 2 V lithium-ion battery than are other active phases in the Li-Ti-O system. The behavior of the spinel electrodes in equilibrium can be described by the Frumkin insertion isotherm model. The value of interaction parameter, g, below -4 indicates that the insertion process leads to a first-order phase transition. Diffusion coefficient of Li in spinel ranges between 10-15 and 10-16 cm2 s-1; the charge transfer kinetics depends on the redox composition. Heterogeneous rate constant ranges between 1 × 10-8 and 4 × 10-10 cm s-1 that is ca. two orders of magnitude higher than that reported for anatase. © 2001 The Electrochemical Society. [DOI: 10.1149/1.1392321] All rights reserved.

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